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(54) Method and device for dithering

(57) The noise occurring when applying dithering on a discrete transfer function shall be reduced. Therefore, a first function value and a second function value are assigned (S1) to a discrete function value of the discrete transfer function. On the basis of a given number of dithering bits dithering values being equal to and/or lying between the first function value and the second function value are calculated (S2). From these dithering values a third function value using the least number of dithering bits is chosen (S3). Finally this third function value is taken as transfer function value instead of the original discrete function value. Thus, the dithering noise can be reduced tremendously.

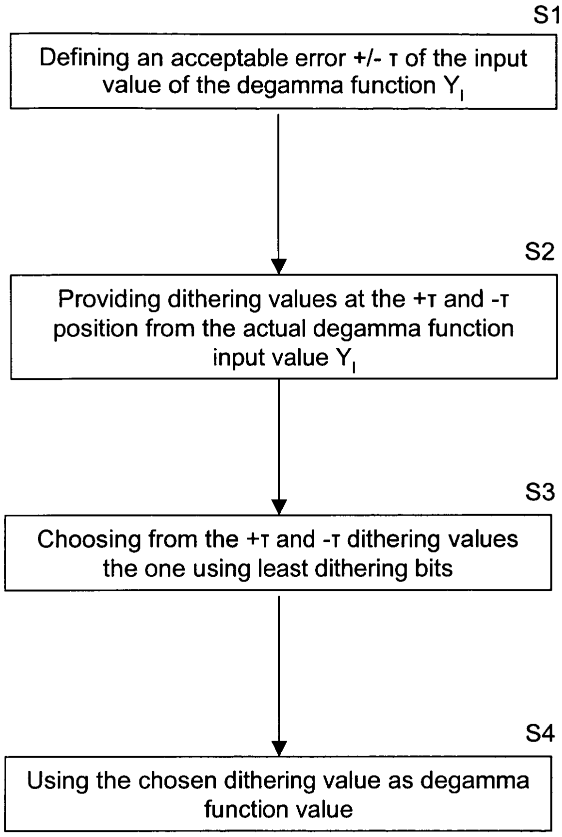

FIG. 3

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Description

[0001] The invention relates to a method for applying dithering to a discrete transfer function used for processing video data. Moreover, the present invention relates to a corresponding device for applying dithering to video data.

Background

[0002] A PDP (plasma display panel) uses a matrix array of discharge cells, which can only be "ON", or "OFF". Also unlike a CRT or LCD in which grey levels are expressed by analogue control of the light emission, a PDP controls the grey level by modulating the number of light pulses per frame (sustain pulses). This time-modulation will be integrated by the eye over a period corresponding to the eye time response. Since the video amplitude is portrayed by the number of light pulses, occurring at a given frequency, more amplitude means more light pulses and thus more "ON" time. For this reason, this kind of modulation is also known as PWM, pulse width modulation.

[0003] This PWM is responsible for one of the PDP image quality problems: the poor grey scale portrayal quality, especially in the darker regions of the picture. Indeed, contrarily to CRTs where luminance is approximately quadratic to the applied cathode voltage, luminance is linear to the number of discharge pulses. Therefore an approximately digital quadratic degamma function has to be applied to video (generally done by a Look-Up Table). To avoid losing amplitude resolution due to this degamma function, a dithering method has to be used.

[0004] Dithering is a well-known technique used to reduce the effects of quantization due to a limited number of displayed resolution bits. There are mainly two kinds of dithering used for PDP:

- Matrix dithering (cf. Cell-Based dithering in patent application EP1269457, and its enhanced version Multi-Mask dithering in patent application EP1262947), which improves gray scale portrayal but adds some dither pattern (structured noise).
- Error-Diffusion, which improves gray scale portrayal and generates no dither pattern, but adds some noise.

[0005] The teaching of the present document aims at reducing the dithering noise appearing with matrix dithering. Error diffusion noise cannot be reduced by the method described here.

[0006] Matrix dithering can in principle bring back as many bits as wanted. However, the dithering noise frequency decreases and therefore the noise becomes more noticeable with an increasing number of dithering bits. In practice with matrix dithering, 3 bits of dithering can be used at the most, because the more bits one uses, the more visible the pattern is.

[0007] The reason for this is that if 3 bits are used for dithering, there will be 8 different dithering patterns, as shown in Figure 1, and the repetition time of a pattern takes 8 clock units. Thus, the repetition frequency of the dithering patterns is low. If more than 3 bits are used for dithering, the repetition frequency will be too low and not acceptable. If only 2 bits of dithering are used, the repetition frequency of the dithering patterns will be two times as high as the repetition frequency of 3 bits dithering.

[0008] Another aspect is that if 3 bits of dithering are used, the pattern of ½ (1st bit of dithering) is quite invisible, the patterns of ¼ and ¾ (2nd bit of dithering) are a bit more visible, while the patterns of 1/8, 3/8, 5/8 and 7/8 (3rd bit of dithering) can be more visible and awkward (compare Figure 1). For example, in case of standard cell-based dithering (patent application EP1269457), the integration of 4 frames of dithering gives the levels shown in Figure 1.

[0009] The values 0, 1/4, 1/2, 3/4 and 1 in each cell of the 4x4 matrix dithering blocks mean that the level 1 is activated 0, 1, 2, 3 or 4 times during the 4 frames. According to this example, the levels 1/8, 3/8, 5/8 and 7/8 are less fine (and so more visible and cumbersome) than the others patterns of dithering.

[0010] The typical block structure of the data processing before the coding step is shown in Fig. 2. 8 bit input data YI are fed into a degamma block 1. The degamma function is realized with the aid of a look-up table LUT#1. An 11 bit output signal YA is transmitted to a matrix dithering block 2. An 8 bit output signal YB from the matrix dithering block 2 is input into a transcoding block 3 applying a second look-up table LUT#2. The resulting output signal after the coding step includes 16 bit data.

[0011] The choice of a dither pattern is made by the degamma LUT, where the dithering bits appear. The matrix dithering block only applies the matrix pattern corresponding to the dithering bits.

[0012] The problem is that dithering bits are really required in the low levels (because of the degamma function), but in the higher levels they are not really necessary, and can on the contrary be unwanted since they add some patterns without adding levels. This will be better explained by an example. The degamma function is defined as follows:

$$Y_A = 255 \times \left(\frac{Y_I}{255} \right)^{\gamma},$$

wherein Y_I is the input data and Y_A the output data of the degamma block 1. γ is the usual exponent of the degamma function. In the example $\gamma = 2.2$

[0013] Even with 3 bits of dithering, some levels between 0 and 21 have the same output, which means loss of levels. But after level 122, all outputs are different even without dithering. This means that without dithering there is no loss of levels but without dithering there is also more quantization noise.

[0014] In the higher levels, dithering can be useful to reduce quantization noise, but it is not necessary to have 3 bits of dithering. However, for example, input levels between 182 and 189 are all using the 3rd bit of dithering as shown in Table 1, which is an extract of Table 3 given in Annex.

Table 1

Input	Output
8 bit	**8.3 bit**
182	121,375
183	122,875
184	124,375
185	125,875
186	127,375
187	128,875
188	130,375
189	131,875

[0015] So for these high levels dither patterns are used, which can be awkward.

Invention

[0016] In view of that, the object of the present invention is to provide a method and a device which enable an improved dithering of quantization steps.

[0017] According to the present invention this object is solved by a method for applying dithering to a discrete transfer function used for processing video data by assigning a first function value and a second function value to a discrete function value of said discrete transfer function, providing dithering values on the basis of a pregiven number of dithering bits, said dithering values being equal to and/or lying between said first function value and said second function value, choosing a third function value from said dithering values, said third function value using the least number of dithering bits and taking said third function value as transfer function value instead of said discrete function value. Thereby the first or second function value may be equal to the discrete function value.

[0018] Furthermore, there is provided a device for processing video data having processing means for applying a discrete transfer function on said video data and dithering means for applying dithering to said discrete transfer function, thereby said dithering means takes a third function value as transfer function value instead of a discrete function value, wherein a first function value and a second function value is assigned to said discrete function value of said discrete transfer function, dithering values on the basis of a pregiven number of dithering bits are provided, said dithering values being equal to and/or lying between said first function value and said second function value, and said third function value is chosen from said dithering values as the value using the least number of dithering bits.

[0019] The advantage of the inventive method and device is that the dithering noise can be reduced tremendously.

[0020] The discrete transfer function may be a degamma function. The effect of the quantization of the degamma function is often very disturbing. Thus, an improved dithering of the degamma function values has a very positively effect.

[0021] The discrete transfer function may be provided by a look-up table. Such LUT improves the processing speed.

[0022] In a specific embodiment the first and the second function values are calculated by modifying a parameter of the discrete transfer function. Especially, the input parameter of the transfer function may be modified. The modification may be performed by adding and subtracting a modifying value to or from the parameter, so that the first and the second function values are obtained by the modified parameter. By doing so an acceptable error will be specified.

[0023] If the dithering values include plural values with the same least number of used dithering bits, the value which lies closer to the discrete function value may be chosen as third function value (which is not an intermediate value generated by dithering). With that, further errors are avoided.

Drawings

[0024] The present invention is illustrated along with the attached drawings showing in:

Figure 1	matrix dithering blocks for cell based dithering;
Figure 2	a block diagram of the data processing before the encoding step according to the prior art; and
Figure 3	a flow chart of the inventive method.

Exemplary embodiments

[0025] The present invention is based on the following knowledge.

[0026] Only a small shift of 0.05 of the input, which corresponds to a small error on the input, would lead to levels using only 1 bit of dithering. So worse dither pattern indicated in table 1 can be avoided without adding significant quantization noise, as shown in the following table 2.

Table 2

Input	Output
	8.3 bit
182,05	121,5
183,05	123
184,05	124,5
185,05	126
186,05	127, 5
187,05	129
188,05	130, 5
189,05	132

[0027] In fact, globally the rounding process makes the probability that the value added by dithering is equal either to 0/8, 1/8, 2/8, 3/8, 4/8, 5/8, 6/8, or 7/8 the same for all levels. So, in principle, the probability that a level uses the 3rd dithering bit (i.e. value added by dithering is equal to 1/8, 3/8, 5/8 or 7/8) is ½.

[0028] When generating the degamma LUT, there are always rounding errors. Now, the idea is to play on this error in order to privilege better dither patterns. In other words, the error has to be estimated and limited.

[0029] The error on the output (quantization error) is not easy to estimate because this error is always relatively smaller in the higher levels than in the low levels (in case of standard encoding). The estimation is worse in case of Gravity Center Coding (cf. patent application EP1256924) or Metacode (cf. patent application EP1353315), because of the non uniform distribution of the levels and the resulting nonuniformity of the quantization error.

[0030] For these reasons, it is easier to consider an error on the input. Specifically, it is easier to estimate and to limit the error.

[0031] So the first step S1 as shown in Figure 3 is to decide the limit τ of the error which will be accepted. A possible value for τ might be 0,1. Two limit curves of the degamma function (compare step S2) are defined as follows:

$$\mathbf{Y}_{-\tau} = \mathbf{255} \times \left(\frac{Y_I - \tau}{255} \right)^{\gamma} \quad \text{and} \quad \mathbf{Y}_{+\tau} = \mathbf{255} \times \left(\frac{Y_I + \tau}{255} \right)^{\gamma}$$

[0032] Table 3, given in Annex, shows the corresponding input values Y_I (first column) and output values Y_A (second and fifth column) of the degamma block 1. The third and fourth column of Table 3 represent the values of the limit curves $Y_{-\tau}$ and $Y_{+\tau}$. Each degamma output value consists of a 8 bit integer and a 3 bit dithering value.

[0033] According to the present invention for each input value a dithering value between Y-τ and Y+τ using the least dithering bits is chosen (compare step S3). This can be seen for instance in the rows of input values 20 and 30. When there are different values having the same number of dithering bits, the closer to the real value has to be chosen. However, if for an actual input value there is an output value between Y-τ and Y+τ having less dithering that the values Y-τ and Y+τ, this value must be chosen. The row of input value 146 shows such an example. Additionally, it has to be regarded to use different output values as far as possible (compare optimized output values for the input values 26 and 27.

[0034] With the standard method (compare second column of Table 3) 131 levels (respectively 61, 28 and 36) are using the 3rd dithering bit (respectively 2nd, 1st and no dithering bit), with the inventively optimized approach only 28 (respectively 63 and 70, and 95).

[0035] The invention can be applied to presently available processing devices without hardware amendment, because only a change of the content of the LUT is necessary. However, advanced processing devices may be able to calculate the optimized LUT automatically. In this case specific calculation means are necessary to perform the method shown in Figure 3.

ANNEX

[0036]

Table 3 (γ = 2,2 and τ = 0,1)

	deGamma Output (8.3 bit)					
Input (8 bit)	**without optimization**		**$Y_{-\tau}$**	**$Y_{+\tau}$**		**with optimization**
0	0		0	0		0
1	0		0	0		0
2	0		0	0		0
3	0		0	0		0
4	0		0	0		0
5	0		0	0		0
6	0,125		0,125	0,125		0,125
7	0,125		0,125	0,125		0,125
8	0,125		0,125	0,125		0,125
9	0,125		0,125	0,125		0,125
10	0,25		0,25	0,25		0,25
11	0,25		0,25	0,25		0,25
12	0,25		0,25	0,25		0,25
13	0,375		0,375	0,375		0,375
14	0,375		0,375	0,375		0,375
15	0,5		0,5	0,5		0,5

Table continued

	deGamma Output (8.3 bit)					
Input (8 bit)	**without optimization**		**$Y_{-\tau}$**	**$Y_{+\tau}$**		**with optimization**
16	0,625		0,625	0,625		0,625
17	0,625		0,625	0,625		0,625
18	0,75		0,75	0,75		0,75
19	0,875		0,875	0,875		0,875
20	1		0,875	1		1
21	1		1	1		1
22	1,125		1,125	1,125		1,125
23	1,25		1,25	1,25		1,25
24	1,375		1,375	1,375		1,375
25	1,5		1,5	1,5		1,5
26	1,625		1,625	1,75		1,625
27	1,875		1,75	1,875		1,75
28	2		2	2		2
29	2,125		2,125	2,125		2,125
30	2,25		2,25	2,375		2,25
31	2,5		2,5	2,5		2,5
32	2,625		2,625	2,625		2,625
33	2,875		2,875	2,875		2,875
34	3		3	3		3
35	3,25		3,25	3,25		3,25
36	3,375		3,375	3,5		3,5
37	3,625		3,625	3,625		3,625
38	3,875		3,875	3,875		3,875
39	4,125		4,125	4,125		4,125
40	4,375		4,25	4,375		4,25
41	4,625		4,5	4,625		4,5
42	4,875		4,75	4,875		4,75
43	5,125		5	5,125		5
44	5,375		5,375	5,375		5,375
45	5,625		5,625	5,625		5,625
46	5,875		5,875	5,875		5,875
47	6,125		6,125	6,25		6,25
48	6,5		6,5	6,5		6,5
49	6,75		6,75	6,75		6,75
50	7,125		7	7,125		7
51	7,375		7,375	7,375		7,375
52	7,75		7,625	7,75		7,625

Table continued

	deGamma Output (8.3 bit)					
Input (8 bit)	without optimization		$Y_{-\tau}$	$Y_{+\tau}$		with optimization
53	8		8	8,125		8
54	8,375		8,375	8,375		8,375
55	8,75		8,75	8,75		8,75
56	9,125		9	9,125		9
57	9,5		9,375	9,5		9,5
58	9,75		9,75	9,875		9,75
59	10,125		10,125	10,25		10,25
60	10,625		10,5	10,625		10,5
61	11		10,875	11		11
62	11,375		11,375	11,375		11,375
63	11,75		11,75	11,75		11,75
64	12,125		12,125	12,25		12,25
65	12,625		12,625	12,625		12,625
66	13		13	13,125		13
67	13,5		13,375	13,5		13,5
68	13,875		13,875	14		14
69	14,375		14,375	14,375		14,375
70	14,875		14,75	14,875		14,75
71	15,25		15,25	15,375		15,25
72	15,75		15,75	15,875		15,75
73	16,25		16,25	16,375		16,25
74	16,75		16,75	16,875		16,75
75	17,25		17,25	17,375		17,25
76	17,75		17,75	17,875		17,75
77	18,25		18,25	18,375		18,25
78	18,875		18,75	18,875		18,75
79	19,375		19,25	19,375		19,25
80	19,875		19,875	20		20
81	20,5		20,375	20,5		20,5
82	21		21	21,125		21
83	21,625		21,5	21,625		21,5
84	22,125		22,125	22,25		22,25
85	22,75		22,625	22,75		22,75
86	23,375		23,25	23,375		23,25
87	24		23,875	24		24
88	24,5		24,5	24,625		24,5
89	25,125		25,125	25,25		25,25

Table continued

	deGamma Output (8.3 bit)					
Input (8 bit)	**without optimization**		**$Y_{-\tau}$**	**$Y_{+\tau}$**		**with optimization**
90	25,75		25,75	25,875		25,75
91	26,375		26,375	26,5		26,5
92	27,125		27	27,125		27
93	27,75		27,625	27,75		27,75
94	28,375		28,375	28,5		28,5
95	29		29	29,125		29
96	29,75		29,625	29,75		29,75
97	30,375		30,375	30,5		30,5
98	31,125		31	31,125		31
99	31,75		31,75	31,875		31,75
100	32,5		32,5	32,625		32,5
101	33,25		33,125	33,25		33,25
102	34		33,875	34		34
103	34,75		34,625	34,75		34,75
104	35,5		35,375	35,5		35,5
105	36,25		36,125	36,25		36,25
106	37		36,875	37		37
107	37,75		37,625	37,875		37,625
108	38,5		38,5	38,625		38,5
109	39,25		39,25	39,375		39,25
110	40,125		40	40,125		40
111	40,875		40,875	41		41
112	41,75		41,625	41,75		41,75
113	42,5		42,5	42,625		42,5
114	43,375		43,25	43,5		43,5
115	44,25		44,125	44,25		44,25
116	45,125		45	45,125		45
117	45,875		45,875	46		46
118	46,75		46,75	46,875		46,75
119	47,625		47,625	47,75		47,75
120	48,625		48,5	48,625		48,5
121	49,5		49,375	49,5		49,5
122	50,375		50,25	50,5		50,5
123	51,25		51,25	51,375		51,25
124	52,25		52,125	52,25		52,25
125	53,125		53	53,25		53
126	54,125		54	54,125		54

Table continued

	deGamma Output (8.3 bit)					
Input (8 bit)	**without optimization**		**$Y_{-\tau}$**	**$Y_{+\tau}$**		**with optimization**
127	55		54,875	55,125		55
128	56		55,875	56,125		56
129	57		56,875	57		57
130	57,875		57,875	58		58
131	58,875		58,75	59		59
132	59,875		59,75	60		60
133	60,875		60,75	61		61
134	61,875		61,75	62		62
135	62,875		62,875	63		63
136	64		63,875	64,125		64
137	65		64,875	65,125		65
138	66		66	66,125		66
139	67,125		67	67,25		67
140	68,125		68,125	68,25		68,25
141	69,25		69,125	69,375		69,25
142	70,375		70,25	70,5		70,5
143	71,375		71,375	71,5		71,5
144	72,5		72,375	72,625		72,5
145	73,625		73,5	73,75		73,5
146	74,75		74,625	74,875		74,75
147	75,875		75,75	76		75,75
148	77		76,875	77,125		77
149	78,25		78,125	78,25		78,25
150	79,375		79,25	79,5		79,5
151	80,5		80,375	80,625		80,5
152	81,75		81,625	81,875		81,75
153	82,875		82,75	83		83
154	84,125		84	84,25		84
155	85,25		85,125	85,375		85,25
156	86,5		86,375	86,625		86,5
157	87,75		87,625	87,875		87,75
158	89		88,875	89,125		89
159	90,25		90,125	90,375		90,25
160	91,5		91,375	91,625		91,5
161	92,75		92,625	92,875		92,75
162	94		93,875	94,125		94
163	95,25		95,125	95,375		95,25

Table continued

	deGamma Output (8.3 bit)					
Input (8 bit)	**without optimization**		**$Y_{-\tau}$**	**$Y_{+\tau}$**		**with optimization**
164	96,5		96,375	96,75		96,5
165	97,875		97,75	98		98
166	99,125		99	99,25		99
167	100,5		100,375	100,625		100,5
168	101,875		101,625	102		102
169	103,125		103	103,25		103
170	104,5		104,375	104,625		104,5
171	105,875		105,75	106		106
172	107,25		107,125	107,375		107,25
173	108,625		108,5	108,75		108,5
174	110		109,875	110,125		110
175	111,375		111,25	111,5		111,5
176	112,75		112,625	112,875		112,75
177	114,25		114,125	114,375		114,25
178	115,625		115,5	115,75		115,5
179	117,125		116,875	117,25		117
180	118,5		118,375	118,625		118,5
181	120		119,875	120,125		120
182	121,375		121,25	121,625		121,5
183	122,875		122,75	123		123
184	124,375		124,25	124,5		124,5
185	125,875		125,75	126		126
186	127,375		127,25	127,5		127,5
187	128,875		128,75	129		129
188	130,375		130,25	130,5		130,5
189	131,875		131,75	132,125		132
190	133,5		133,375	133,625		133,5
191	135		134,875	135,125		135
192	136,625		136,375	136,75		136,5
193	138,125		138	138,375		138
194	139,75		139,625	139,875		139,75
195	141,375		141,125	141,5		141,25
196	142,875		142,75	143,125		143
197	144,5		144,375	144,75		144,5
198	146,125		146	146,375		146
199	147,75		147,625	148		148
200	149,375		149,25	149,625		149,5

Table continued

	deGamma Output (8.3 bit)					
Input (8 bit)	**without optimization**		**$Y_{-\tau}$**	**$Y_{+\tau}$**		**with optimization**
201	151,125		150,875	151,25		151
202	152,75		152,625	152,875		152,75
203	154,375		154,25	154,625		154,5
204	156,125		155,875	156,25		156
205	157,75		157,625	157,875		157,75
206	159,5		159,25	159,625		159,5
207	161,125		161	161,375		161
208	162,875		162,75	163		163
209	164,625		164,5	164,75		164,5
210	166,375		166,125	166,5		166,5
211	168,125		167,875	168,25		168
212	169,875		169,625	170		170
213	171,625		171,5	171,75		171,5
214	173,375		173,25	173,625		173,5
215	175,25		175	175,375		175
216	177		176,75	177,125		177
217	178,75		178,625	179		179
218	180,625		180,375	180,75		180,5
219	182,5		182,25	182,625		182,5
220	184,25		184,125	184,5		184,5
221	186,125		186	186,375		186
222	188		187,75	188,125		188
223	189,875		189,625	190		190
224	191,75		191,5	191,875		191,5
225	193,625		193,375	193,75		193,5
226	195,5		195,375	195,75		195,5
227	197,375		197,25	197,625		197,5
228	199,375		199,125	199,5		199,5
229	201,25		201,125	201,5		201,5
230	203,25		203	203,375		203
231	205,125		205	205,375		205
232	207,125		206,875	207,375		207
233	209,125		208,875	209,25		209
234	211,125		210,875	211,25		211
235	213		212,875	213,25		213
236	215		214,875	215,25		215
237	217,125		216,875	217,25		217

Table continued

	deGamma Output (8.3 bit)					
Input (8 bit)	**without optimization**		**$Y_{-\tau}$**	**$Y_{+\tau}$**		**with optimization**
238	219,125		218,875	219,25		219
239	221,125		220,875	221,375		221
240	223,125		223	223,375		223
241	225,25		225	225,375		225
242	227,25		227,125	227,5		227,5
243	229,375		229,125	229,5		229,5
244	231,375		231,25	231,625		231,5
245	233,5		233,25	233,75		233,5
246	235,625		235,375	235,875		235,5
247	237,75		237,5	238		237,5
248	239,875		239,625	240,125		240
249	242		241,75	242,25		242
250	244,125		243,875	244,375		244
251	246,25		246,125	246,5		246,5
252	248,5		248,25	248,625		248,5
253	250,625		250,375	250,875		250,5
254	252,75		252,625	253		253
255	255		254,75	255,25		255

Claims

1. Method for applying dithering to a discrete transfer function used for processing video data **characterized by**

   - assigning (S1) a first function value and a second function value to a discrete function value of said discrete transfer function,
   - providing (S2) dithering values on the basis of a pregiven number of dithering bits, said dithering values being equal to and/or lying between said first function value and said second function value,
   - choosing (S3) a third function value from said dithering values, said third function value using the least number of dithering bits and
   - taking (S4) said third function value as transfer function value instead of said discrete function value.

2. Method according to claim 1, wherein said discrete transfer function is a degamma function.

3. Method according to claim 1 or 2, wherein said discrete transfer function is provided by a look-up table.

4. Method according to one of the preceding claims, wherein said first and second function values are calculated by modifying a parameter of the discrete transfer function.

5. Method according to claim 4, wherein said parameter is modified by adding and subtracting a modifying value to or from said parameter, and said first and second function values are obtained by said modified parameter.

6. Method according to one of the preceding claims, wherein, if the dithering values include plural values with the same least number of used dithering bits, the value which lies closer to said discrete function value is chosen as third function value.

7. Device for processing video data having

- processing means (1) for applying a discrete transfer function on said video data and
- dithering means (2) for applying dithering to said discrete transfer function,

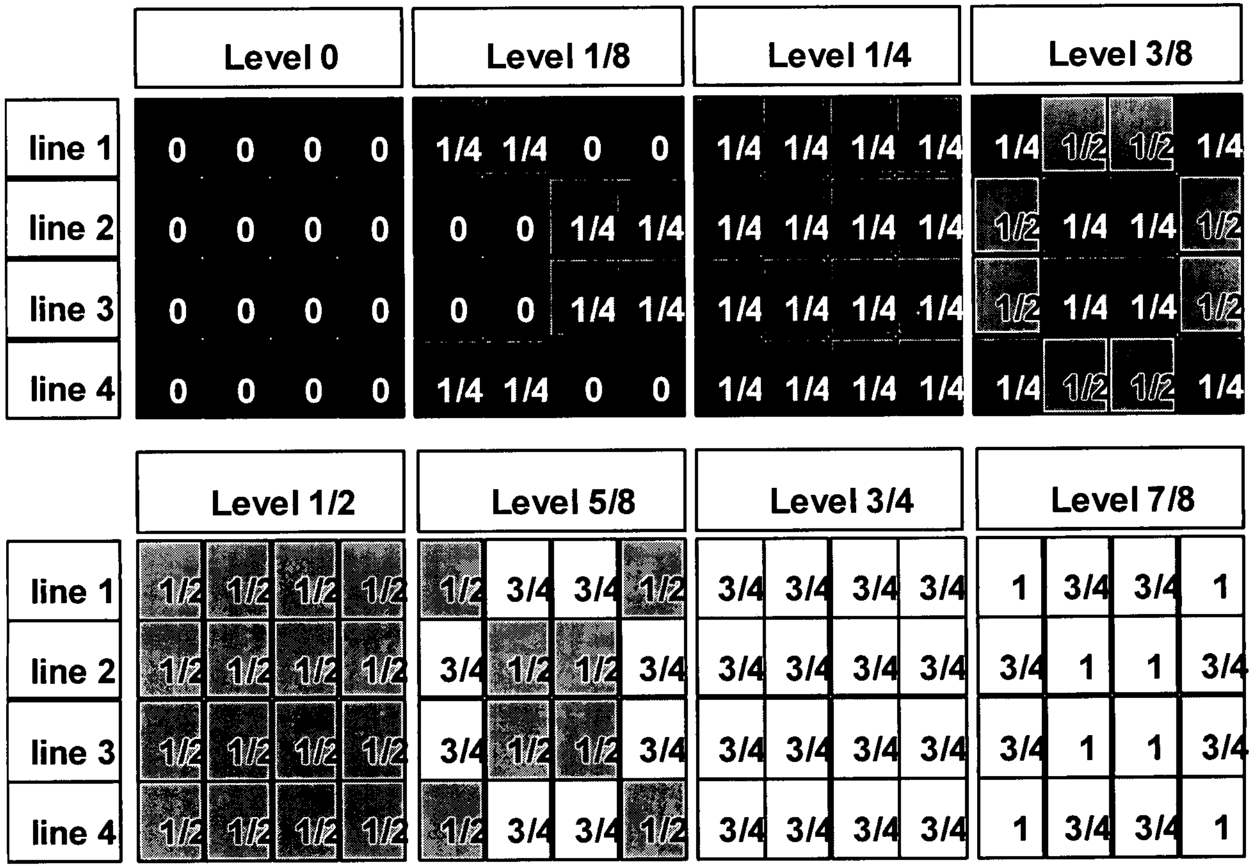
characterized in that

- said dithering means (2) takes a third function value as transfer function value instead of a discrete function value, wherein a first function value and a second function value is assigned to said discrete function value of said discrete transfer function, dithering values on the basis of a pregiven number of dithering bits are provided, said dithering values being equal to and/or lying between said first function value and said second function value, and said third function value is chosen from said dithering values as the value using the least number of dithering bits.

8. Device according to claim 7, wherein said discrete transfer function is a degamma function.

9. Device according to claim 7 or 8, having storing means for providing said discrete transfer function in a look-up table.

10. Device according to one of the claims 7 to 9, wherein said dithering means (2) is suitable for calculating said first and said second function values by modifying a parameter of the discrete transfer function.



	Level 0				Level 1/8				Level 1/4				Level 3/8			
line 1	0	0	0	0	1/4	1/4	0	0	1/4	1/4	1/4	1/4	1/4	1/2	1/2	1/4
line 2	0	0	0	0	0	0	1/4	1/4	1/4	1/4	1/4	1/4	1/2	1/4	1/4	1/2
line 3	0	0	0	0	0	0	1/4	1/4	1/4	1/4	1/4	1/4	1/2	1/4	1/4	1/2
line 4	0	0	0	0	1/4	1/4	0	0	1/4	1/4	1/4	1/4	1/4	1/2	1/2	1/4

	Level 1/2				Level 5/8				Level 3/4				Level 7/8			
line 1	1/2	1/2	1/2	1/2	1/2	3/4	3/4	1/2	3/4	3/4	3/4	3/4	1	3/4	3/4	1
line 2	1/2	1/2	1/2	1/2	3/4	1/2	1/2	3/4	3/4	3/4	3/4	3/4	3/4	1	1	3/4
line 3	1/2	1/2	1/2	1/2	3/4	1/2	1/2	3/4	3/4	3/4	3/4	3/4	3/4	1	1	3/4
line 4	1/2	1/2	1/2	1/2	1/2	3/4	3/4	1/2	3/4	3/4	3/4	3/4	1	3/4	3/4	1

FIG. 1

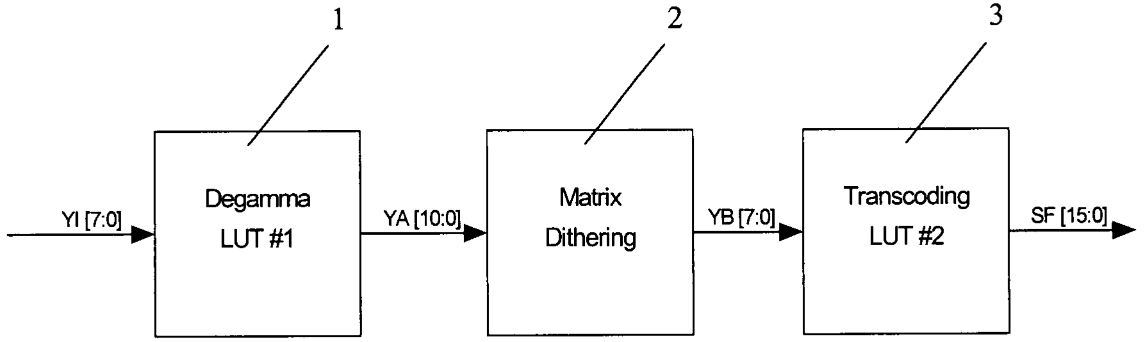

1
2
3
YI [7:0]
Degamma
LUT #1
YA [10:0]
Matrix
Dithering
YB [7:0]
Transcoding
LUT #2
SF [15:0]

FIG. 2

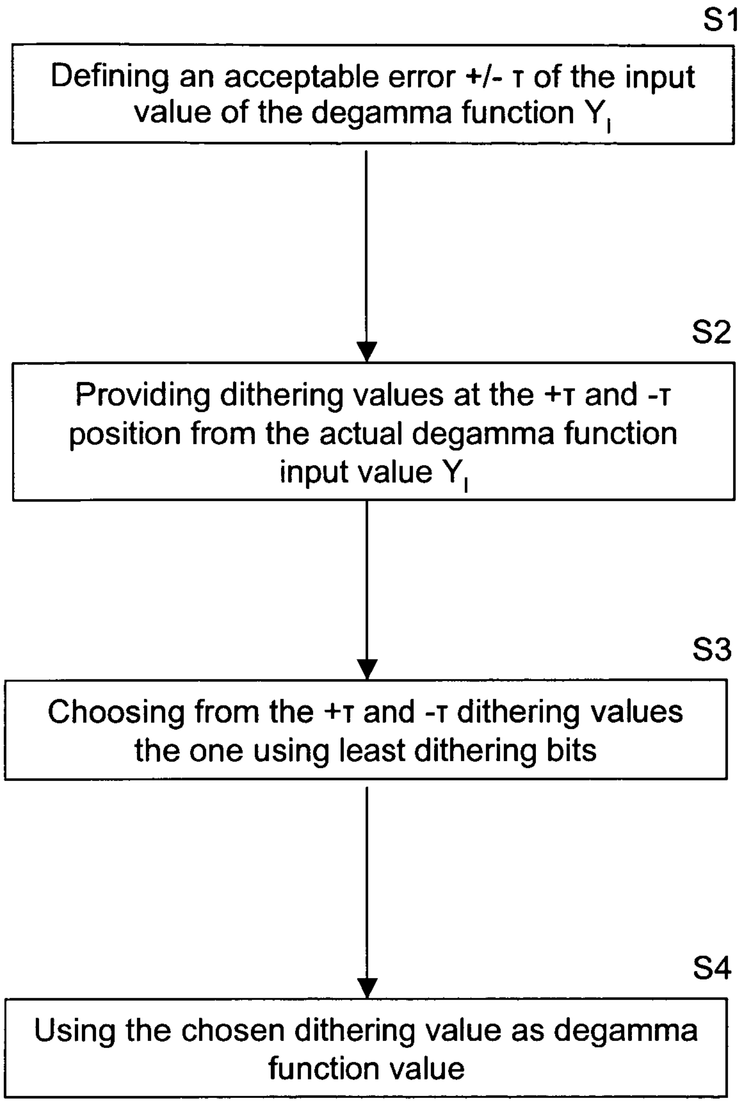

S1
Defining an acceptable error +/- τ of the input value of the degamma function Y_I
S2
Providing dithering values at the +τ and -τ position from the actual degamma function input value Y_I
S3
Choosing from the +τ and -τ dithering values the one using least dithering bits
S4
Using the chosen dithering value as degamma function value

FIG. 3

European Patent Office

EUROPEAN SEARCH REPORT

Application Number
EP 04 29 2087

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int.Cl.7)
A	EP 1 324 305 A (SEIKO EPSON CORPORATION) 2 July 2003 (2003-07-02) * abstract; figure 16 * -----	1,7	G09G3/20 G09G3/28
A	PATENT ABSTRACTS OF JAPAN vol. 2000, no. 04, 31 August 2000 (2000-08-31) & JP 2000 023181 A (HITACHI LTD), 21 January 2000 (2000-01-21) * abstract; figure 1 * -----	1,7	

TECHNICAL FIELDS SEARCHED (Int.Cl.7)
G09G

The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	15 February 2005	Amian, D

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
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T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons
……………………………………………………………………
& : member of the same patent family, corresponding document

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ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 04 29 2087

15-02-2005

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JP 2000023181 A	21-01-2000	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82